AGGLUTINATES AND NANOPHASE SUPERPARAMAGNETIC IRON IN SURFACE SOILS ON THE MOON. A. Basu and C. E. Yokoyama, Department of Geological Science, Indiana University, Bloomington IN 47405, USA (basu@indiana.edu).

Summary: High-resolution model estimates of agglutinate content in 56 lunar soils show that there are more agglutinates per unit I_s/FeO in relatively Fe-rich soils indicating that agglutinate production is dependent on the Fe content of a soil. There is an apparent excess of I_s/FeO in relatively Ti-rich soils, which may suggest that production of nanophase superparamagnetic iron may be dependent on ilmenite abundance in lunar soils.

Introduction: Comminution products of the same parent rock may produce different UV-VIS-IR reflectance spectra [e.g., 1] under identical solar radiation, depending on size-distribution and the proportions of glass and nanophase superparamagnetic iron (np-Fe^0). We are continuing to investigate the origin of glass and np-Fe^0 in the lunar regolith [2] as a consequence of space weathering from the perspective of regolith petrology to help better interpret remote sensing signals. We are experimenting with a modified criterion for identifying agglutinates in polished grain mounts and a grid method for estimating the model abundance of agglutinates. We report on the results of our new model analysis of 13 Apollo 16 and 27 Apollo 17 surface soils in the 90–150 µm fraction and compare the results with literature data on I_s/FeO of the same soils [3].

Method: Instead of using the criteria for identifying agglutinates in polished grain mounts, which has been developed over the years [4,5], we have used a modified version for the purpose of this study only. We are excluding agglutinates that contain very little (<10%) agglutinitic glass even if, for example, two mineral grains may be clearly bonded by such glass. We are, however, including those that may have agglutinitic glass and dusty material on the rind provided such material exceeds 10% of the total surface area of the grain mount, even if no other mineral grain (>2 µm) may be bonded by such glass. We have checked the reproducibility of our method by comparing the visual identification of two different operators. In a further deviation from our previous practice, we have employed a spread-out grid pattern (spacing > 150µm) for our model analysis (500 points = 500 grains) to cover the whole grain-mount instead of numbering all grains in a randomly selected area of an enlarged photomosaic [e.g., 6].

Results and Discussion: A comparison with literature data on agglutinate concentration and I_s/FeO shows that our new high-resolution model analyses of relatively glass-rich agglutinates are consistent with the trends found earlier (Table 1; Fig. 1a,b). Our new data show a better correlation with I_s/FeO than that shown by agglutinate percent measured in a conventional way and reported in the literature (0.89 vs. 0.85, and 0.94 vs. 0.85). This suggests that np-Fe^0 in a soil, inasmuch as is represented by I_s/FeO, is resident in agglutinitic glass [7]. There are more agglutinates per unit I_s/FeO in the relatively Fe-rich Apollo 17 soils (m = 0.43) than in Apollo 16 soils (m = 0.36) indicating that agglutinate production is dependent on the Fe content of a soil provided that I_s/FeO is independent of Fe content in any soil. Because A17 samples include mixtures of both mare and highland soils, and because A16 soils are mostly of highland derivation, the correlation between agglutinate and I_s/FeO is better in the A16 data, which is compatible with the above conclusion.

Note that Apollo 17 soils seem to have fewer agglutinates per unit I_s/FeO than Apollo 12 soils although the Fe-contents of both are not that different, i.e., Apollo 17 soils have an apparent excess of I_s/FeO. Apollo 17 soils are, however, relatively rich in Ti, i.e., in ilmenite. Therefore, our preliminary data suggest that either agglutinate production is dependent also on ilmenite or np-Fe^0 production is dependent on ilmenite. We suggest that np-Fe^0 is by far more concentrated in ilmenite than in any other mineral. Recent TEM imaging shows ilmenite rinds to be by far more riddled with fine Fe^0, presumably np-Fe^0, than other minerals in lunar soils [8–10]. Ilmenite also hosts solar wind hydrogen far in excess of other minerals [11], which may be related to np-Fe^0. It is possible, but not proven yet, that the excess np-Fe^0 in ilmenite rinds contributes to the excess I_s/FeO in Apollo 17 soils.

Table 1. Correlation matrix between new and literature data on agglutinate % and Is/FeO.

A 16	Is/FeO	Lit	New	A 17	Is/FeO	Lit	New
Is/Feo	1		n = 13	Is/FeO	1		n = 27
Lit	0.84	1.00		Lit	0.85	1.00	
New	0.94	0.84	1	New	0.89	0.89	1

Linear regression (y = agglutinate %; x = Is/FeO; A12 and A14 data from [12].

A 17	$y = 0.43x + 10.1$	$R^2 = 0.80$	A 16	$y = 0.36x + 0.08$	$R^2 = 0.89$
A 14	$y = 0.50x + 5.88$	$R^2 = 0.89$	A 12	$y = 0.65x + 7.12$	$R^2 = 0.80$

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